VI. WORK PRACTICES

(a) General

Since there are many thousands of uses for fibrous glass, a discussion of work practices must be limited to a consideration of general principles; however, work practices for some specific types of operations involving fibrous glass are discussed in Appendix VI. In a majority of uses of fibrous glass, other possibly more hazardous materials are also involved. In such cases, the work practices are primarily aimed at controlling the greater hazard. Generally, the principles involved are similar for most hazardous substances and basically involve following fundamental industrial hygiene practices. Industries, alone or in cooperation with trades, that work with fibrous glass should be required to develop their own specific codes of work practices. The National Insulation Manufacturers Association has published its recommended health practices for handling and applying thermal insulation products containing mineral fibers [107]. Many of its recommendations are also applicable to other uses of fibrous glass products.

(b) Personal Hygiene

With fibrous glass and many of the plastics with which it is used, the observance of good personal hygiene is of primary importance if dermatologic problems are to be avoided or minimized. Conveniently located hand washing facilities should be provided and employees should be instructed as to the importance of their proper use [24,33]. In addition, exposed workers should shower at the end of the work shift before changing into street clothes.

Special consideration should be given to the laundering of work clothes exposed to fibrous glass. Contamination of other clothes that come in contact with work clothes in laundry machines has been observed [25,33]. In operations where clothes are laundered under contract, it is important to inform contractors of the hazards of laundering clothes contaminated with fibrous glass.

Glass fibers larger than about 5 μm in diameter have been found to cause skin irritation in experimental situations but this was not found with smaller diameter fibers [27].

Most skin problems arise from direct contact with fibrous glass through handling rather than from airborne fibers or dust. Decisions on whether to use gloves or other protective clothing will depend on the nature of the work as well as the nature of the materials involved [21]. Where the exposure is limited to fibrous glass, experience has generally demonstrated that the use of gloves is not always indicated. Some workers regularly exposed to fibrous glass seem to become toughened to the fibers and may not need to wear gloves. Those with only intermittent exposures may not become "hardened" to the fibers. For intermittent jobs such as tear-out of insulation materials, gloves and also general skin protective clothing should be worn.

(c) Housekeeping

Good housekeeping practices are essential for minimizing exposures to fibrous glass [21,107]. Vacuum cleaning, washdown procedures, and wet sweeping should be used where practical to control or reduce airborne concentrations of fibrous glass dust. Dry sweeping or the use of compressed air to remove dust should be prohibited. Scrap materials and debris should not be allowed to accumulate. Waste materials should be placed in suitable, covered storage containers located as close as possible to the point of origin of the waste. Disposal should be by methods which will ensure that fibrous glass will not disperse into the atmosphere.

The feasibility of engineering control methods such as dilution or exhaust ventilation and enclosure will vary, depending on whether operations are being performed at fixed locations or in the field, including construction sites. As indicated earlier, most uses of fibrous glass are likely to also involve other potentially hazardous substances such as resins, solvents, and plasticizers. Information on many of the substances used in conjunction with fibrous glass may be found in the NIOSH publication Fiberglass Layup and Sprayup--Good Practices For Employees, published in April 1976 [108].

(d) Respiratory Protective Devices

Respiratory protective devices are not needed for fibrous glass exposures below the recommended environmental limit. For situations where airborne concentrations may exceed the limits recommended, respirators approved by NIOSH or the Mining Enforcement and Safety Administration (MESA) under provisions of 30 CFR 11, may be used but not as a substitute for feasible engineering controls. Whenever respirators are used, a respirator program conforming to the requirements of the occupational safety and health standards for respiratory protection, 29 CFR 1910.134, should be followed. Respirators may be needed on such potentially dusty work as tear-out and blowing operations in confined spaces [40]. When feasible, exhaust ventilation of the enclosure should be used to provide general room air changes and limit the need for wearing respirators. The air must not be exhausted into other work areas. Respirators are not recommended to be used as primary control measures in lieu of appropriate environmental engineering controls during routine, ongoing operations.

(e) Eye Protection

Eye protection, consisting of safety goggles or face shields and goggles are recommended for use in work necessitating tear-out, blowing, or at any time when there is the likelihood of getting large quantities of airborne fibrous glass in the eyes, such as when applying insulation overhead [36,105].

VII. RESEARCH NEEDS

Little is known about the fate and health hazards of inhaled fibrous glass of small diameters. Since glass fibers measuring less than 3.5 µm in diameter are relatively new in commercial products, exposed groups have not been identified from epidemiologic data. A need exists for studies of the effects of small-diameter fibrous glass (less than 3.5 µm and especially less than 1 µm on specific cohorts over long periods of time. An epidemiologic study on the mortality experience of 12,000 workers, sponsored by the Thermal Insulation Manufacturers Association (TIMA), is now in progress on occupational exposures to manufactured (manmade) mineral fibers including fibrous glass. The study, consisting of 3 groups of workers, is scheduled to be completed in phases between June 1977 and May 1978. Although these groups have been exposed primarily to fibers greater than 1 to 3.5 µm in diameter, they also have been exposed to fibers less than 1 µm. Also, the exposures are claimed to have been for a sufficient period of time to hopefully answer questions concerning the demonstrated latent period observed for many occupational carcinogens. Further research involving retrospective and prospective epidemiologic studies of other populations exposed predominantly to fibers less than 1 µm in diameter is desirable.

Another current study, also sponsored by TIMA, may give better insights on environmental concentrations, fiber characterizations, and durations of exposure. This information should aid in correlation of industrial hygiene data with epidemiologic data to determine the presence of dose-response relationships.

Questions remain concerning the effects of fibrous glass larger than 3.5 μm in diameter. The observation that an inordinate number of cases (6) of bronchiectasis were present among the deaths reported by Bayliss et al [55] out of a total of 25 deaths due to nonmalignant respiratory disease among workers with fibrous glass, needs confirmation and demonstration of the pathogenic role of glass fibers, if possible. A case-control pairing would be an adequate design for the study of bronchiectasis which is rarely reported independently as an entity in US vital statistics. A case-control study should include consideration of exposure concentrations, fiber size, and duration of employment. Cases of bronchiectasis should be matched on a variety of dependent variables; this would involve using many controls for each case.

Environmental data exist for large manufacturing and production operations involving fibrous glass; however, little data are available, but research recently initiated may meet the need to detail exposures that may occur in small shops, tear-out of insulation on renovation or demolition jobs, or for other "on location" situations. Such exposures should be characterized so that appropriate work practices and control procedures may be recommended for the future. More information is needed on the exact extent of exposures to fibrous glass with diameters less than 3.5 μm.

There is a need for continued testing and development of analytic methods for fibrous glass so that precision and accuracy may be determined. The development of other more rapid and efficient methods of analysis would be useful.

A need exists for a variety of animal studies involving fibrous glass, especially long-term investigations of chronic effects of fibers of varying dimensions. Studies are needed on the mechanism of fibrogenesis and carcinogenesis with fibrous material. Such studies should address entry and biologic availability of fibrous material in the occupational environment with due regard for host defense mechanisms, species differences in response, and considerations of dose-response and no-effect levels. Inhalation studies of glass fibers using guinea pigs would be especially useful to enable comparisons with existing findings from intratracheal instillations in these animals [61,64]. Information is also lacking on the fate of inhaled glass fibers. TIMA indicates that a two-phase activity is in process for preparation of sample materials for exposure experiments and identification of available inhalation facilities and scientific and technical expertise. Elucidation of possible clearance and translocation mechanisms is needed. These types of studies would serve as a basis for the evaluation of the recommended environmental limit.

The International Agency for Research on Cancer is currently investigating the health risks from occupational exposure during production of manufactured mineral fibers throughout Western Europe. In addition, the use of neutron-activated fibrous materials is being studied for anatomic and metabolic fate at the Atomic Energy Research Establishment (AERE) in the United Kingdom along with studies which are under consideration by the Pneumoconiosis Research Unit in Cardiff, Wales, on the bioassay of inhaled, defined fibrous particles.

A further question needing clarification is the physical fate of manufactured (manmade) mineral fibers, with emphasis on splitting, fragmentation, solubility, and the relation of these properties to tissue effects.

The above description of research needs evidences the insufficiency of data with regard to the potential health effects of long, thin fibers, especially those smaller than about 1 μm in diameter. Current research attempting to satisfy these research needs may fill a considerable part of the gap within a few years.

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IX. APPENDIX I

AIR SAMPLING METHOD - MEMBRANE FILTER

General Requirements

The following sampling and anlytical methods for fiber counting are adapted from the NIOSH membrane filter method for evaluating airborne asbestos fibers [90].

(a) Air samples representative of the breathing zones of workers must be collected to characterize the exposure from each job or specific operation in each work area.

(b) Samples collected shall be representative of the exposure of individual workers.

(c) Suggested records:

(1) The date and time of sample collection.

(2) Sampling duration.

(3) Total sample volume.

(4) Location of sampling.

(6) Other pertinent information.

Sampling

(a) Samples shall be collected so as to be representative of the breathing zones of workers without interfering with their freedom of movement.

(b) Samples shall be collected to permit determination of TWA exposures for every job involving exposure to fibrous glass in sufficient numbers to determine the variability of exposures in the work situation.

(c) Equipment

The sampling train consists of a membrane filter and a vacuum pump.

(1) Membrane filter: Samples of fibrous glass are collected in the breathing zones of the workers using a personal sampler with cellulose ester membrane filter. The filter is a 0.8-μm pore size mixed cellulose ester membrane mounted in a open-face sampling cassette which can be attached to the worker near his or her breathing zone.

(2) Pump: A battery-operated pump, complete with clip for attachment to the worker's belt, capable of operation at 2.5 liters/minute or less.

(d) Calibration

The personal sampling pump should be recharged prior to calibration and then calibrated against a bubble meter, wet test meter, spirometer, or similar device at a flowrate of 1.0 to 2.5 liters/minute. The sampling train used in the calibration (pump, hose, filter) shall be equivalent to the one used in the field. The calibration should be performed to an accuracy of $\pm$ 5%.

(e) Sampling Procedure

(1) Sampling is performed using an open-face membrane filter cassette.

(2) The sampler shall be operated at a flowrate between 1.5 and 2 liters/minute.

(3) The temperature and pressure of the atmosphere being sampled are measured and recorded.

(4) One membrane filter is treated in the same manner as the sample filters with the exception that no air is drawn through it. This filter serves as a blank.

(5) Immediately after sampling, personal filter samples should be sealed in individual plastic filter holders for shipment. The filters shall not be loaded to the point where portions of the sample might be dislodged from the collecting filter during handling.

(f) Optimum Sampling Times

A requirement for a minimum count of 100 fibers or 20 fields has been determined to be the optimum choice to achieve low variability of the fiber count (as approximated by a Poisson distribution) and reduced counting times. In other words, the optimum fiber density on the filter should be 1 to 5 fibers/microscope counting field. To estimate optimum sampling times, the approximate field area of the counting scope and the pump flowrate must be known in advance.

The following equation is used to calculate the range of optimum sampling times which can then be plotted on log-log paper:

$$\text{Minutes} = \frac{(FB/FL)(ECA/MFA)}{(FR)(AC)}$$

where: FB/FL = 1 to 5 fibers/field

ECA = Effective collecting area of filter in square millimeters (855 square mm for 37-mm filter)

MFA = Microscope field area in mm (generally 0.003 to 0.006 square mm)

FR = Pump flowrate in cc/minute

AC = Air concentration of fibers in fibers/cc

(NOTE: If air concentrations are expressed in fibers/cu m they must be changed to fibers/cc for this equation.)